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ABSTRACT

This paper surveys past and current theories about the workings of the mind, current brain research and psychological applications of non-linear dynamics. Parallels are drawn between the world of high-functioning autism, gifted individuals with learning disabilities, and aspects of genius. An organizing theory is presented, which includes these three groups as well as a broader population. Recommendations for educating students with different characteristics are made. Chapter 1 addresses brain hemispheric preferences, defines characteristics of the left and right hemispheres of the brain, and discusses learning style theory, multiple intelligences, the Triune Brain Theory, the Somatic Marker theory, how neurons work, and chaos concepts. Chapter 2 discusses the common ground between individuals with high-functioning autism, giftedness and learning disabilities, and genius characteristics. High intelligence, uneven skill development, perceptual anomalies, and difficulties in communication are highlighted common characteristics. Family traits and genetic links are also discussed. The final chapter uses the qualities of self-mastery, the need to invent, and the ability to communicate to classify different types of individuals. Separate lists of educational strategies to address these differences are provided for students, parents, teachers, and administrators. (Contains 44 references.) (CR)

Genetic Wild Card

A marker for Learners At Risk

Master's Thesis

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Grand Valley State University

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Dedication

To my sons, Rafael, Loren and Cory for all they have taught me,

and to my parents, Dottie and Glen for their love and suppport.

Abstract

This paper will survey past and current theories about the workings of the mind, current brain research and psychological applications of non-linear dynamics. Parallels will be drawn between the world of high-functioning autism, the Gifted/Learning disabled population, and aspects of genius. An organizing theory will be presented, which includes these three groups as well as a broader population. Finally, some recommendations will be made.

These three disparate groups have some common ground. In general, they all have unique educational needs. Except for the diagnosed special education students, their distinct needs are rarely perceived, let alone met. Highlighting this unique population may serve to draw attention to the difficulties facing many of these people, and point to some directions for future problem solving.

In the population to be described, many individuals are smart. They are curious and creative. They can be musical, artistic, scientific, and/or poetic. They perceive the world in unique ways. They experience frustration, tedium, and moments of clarity. They cope with dignity, become invisible, and/or act out. They pursue single-minded interests. They follow their own drummer. Often, they have allergies, suffer from depression, and experience synthesethia, an involuntary experience of mixed sensations of the senses. They are prone to experience mood disorders and often have learning differences. Some are socially gauche. Others are extremely sensitive. Still others are

naive. Many are idealistic. There are as many variations within this group as there are people, but as individuals, they are never ordinary.

Chapter One

Survey of Literature

Theories

Theories are an odd mixture of truth and fill-in-the-blank. A mixture of intellipent guess work, keen observation, confabulation, conjecture, and imagination combines with factual knowledge to give the theory its shape and form. Theories have a way of evolving, the recent, adding to that which came before. When new theories finally replace the old, the sums of the old and new determine the direction of future growth. Theories give structures to how empty spaces are filled when information is missing.

Filling in the gaps where there is missing information is an activity in which people frequently engage. This is due to the fact that sensory input is often fragmentary. Consider the following: If you wear glasses, take them off, if you do not, borrow a pair to wear. With your blurred vision, stand at a bookshelf and attempt to read the titles of the books. The individual letters should not be recognizable. After you have attempted to read several titles, restore your vision and check your accuracy. The word millennium may have become millimeter. You are doing pretty well if the Cosmic Universe only became the Comic Universe. If you were to do this often, you might become pretty good at it. Your accuracy would improve as you memorized key shapes, noticed repeated patterns, practiced using contextual clues, eliminated the absurd, searched for meaning, developed alternative strategies and coping skills. Glasses are a

simple, practical tool for improving incomplete and distorted visual input. Many other sensory input problems are not that easy to improve.

Some of us have an easier time making sense out of the world than others. Those who work harder than most may, in the long run, be developing valuable skills. The abilities to persist, verify, question, experiment, evaluate, and judge are strengthened. Those people who develop such skills may be just the ones to lead us into the twenty-first century.

Astrology to Neuroscience

There are many theories as to how and why people are similar and different. This puzzle has occupied humankind for thousands of years. The ancients speculated that patterns in personalities had to do with the movements of the planets and stars. In modern times, Franz Joseph Gall (1758-1828) presented the theory that personality traits could be "read" by the size and placement of bumps on a person's head. Phrenology, as it was called, has long fallen by the wayside, yet the insight that was the foundation of the theory has been validated by recent research. That is, that certain areas of the brain perform specific functions.

Until recently, we have had only vague ideas about the functioning of the brain. Sigmund Freud (1856-1939) created a model from the limited information available to him. His theory divided the inner workings of the human mind into an ego, super-ego, and id, each with its own particular job. Carl Jung, (1875-1961) a student of Freud, developed another model. He saw people as being introverted, extroverted, sensing, intuiting, feeling, and thinking in various combinations and proportions. The terms

intuiting, feeling, and thinking in various combinations and proportions. The terms archetype and collective consciousness came into common usage through his work. Both Freud's and Jung's theories are still in use today by reputable professionals. Other schools of thought have followed. Skinner (1904-1990) viewed all behavior as a response to some kind of stimulus. Piaget (1896-1980) contributed a developmental model, where children move through successive stages on their way to becoming functioning adults. There are others, each contributing a perspective and giving educators, counselors and therapists a collection of models and tools from which to ply their trades.

Now, in the age of computers, electron microscopes, CAT scans, MRI's and other new techniques for measuring and gathering information, we have an array of new information that is much more reliable and accurate than earlier speculated. Each has its limitations of applications, and yet encourages and confirms that there is much, much more to be discovered.

Hemispheric Preference

Brain research has spawned some new theories of learning. Educators are finding classroom applications for this recent information. Over time, this could aid the construction of much needed improvements as to how education is delivered.

The first view of learning based on brain research was the hemispheric, or the split brain theory. It was developed through the treatment of individuals who had debilitating epileptic seizures. In these people, the tissue which connected the two halves of the cerebellum, the corpus collosum, was surgically severed, separating and isolating the

two halves of the brain. The treatment was a success with an interesting aside. It was discovered that the two halves are not the same, but perform complementary tasks. The right half of the brain controls the left side of the body and the left half of the brain controls the right side of the body. Scientists postulated that "both hemispheres are involved in higher cognitive functioning, with each half of the brain specialized in complementary fashion for different modes of thinking, both highly complex." (Edwards, 1979) Hemispheric theory was of great interest to educators. It offered an explanation of why some students learned and others did not. It also offered a prescription to remedy the situation. Artists and musicians also recognize their experience in the hemispheric theory. When both halves of the brain work effectively in concert, the resulting experience is both satisfying and exhilarating. Betty Edwards, art teacher and author of *Drawing on the Right Side of the Brain*, compares left mode and right mode characteristics.

Left hemisphere characteristics

Verbal - Using words to name, describe, define.

Analytic - Figuring things out step-by-step and part-by-part.

Symbolic - Using a symbol to stand for something.

Abstract - Taking out a small bit of information and using it to represent the whole thing.

Temporal - Keeping track of time, sequencing one thing after another: Doing first things first, second things second, etc.

Rational - Drawing conclusions based on reason and facts.

Digital - Using numbers as in counting.

Logical - Drawing conclusions based on logic: one thing following another in logical order - for example, a mathematical theorem or well stated argument.

Linear - Thinking in terms of linked ideas, one thought directly following another, often leading to a convergent solution.

Right Hemispheric Characteristics

Non-verbal - Awareness of things, but a minimal connection with words.

Synthetic - Putting things together to form wholes.

Concrete - Relating to things as they are at the present moment.

Analogic - Seeing likenesses between things; understanding metaphoric relationships.

Nontemporal - Without a sense of time.

Nonrational - Not requiring a basis of reason or facts; willingness to suspend judgment.

Spatial - Seeing where things are in relation to other things, and how parts go together to form a whole.

Intuitive - Making leaps of insight, often based on incomplete patterns, hunches, feelings or visual images.

Holistic - Seeing whole things all at once; perceiving the overall patterns and structures, often leading to divergent conclusions. (Edwards, 1979, p. 40)

Although the split-brain theory was ground-breaking, today the hemispheric theory is seen as simplistic. There is much more to understanding mind, memory, and learning than the action of, and interaction between the two hemispheres. Hemispheric theory was a stepping stone to a more complete understanding and it is a useful model for communicating, understanding learners, and organizing curriculum.

Learning Style Theory

The theory of learning styles connects brain research with education. Because of the complexity of the brain, no person processes information exactly the same way as another person. Even in identical twins, the patterns of neurons differ and create differences in style. Learning style is exhibited in the way a person begins to process new and challenging material. Most people can learn in a variety of styles. However, the more difficult the learning task, the stronger the tendency will be to choose the learning style which is most highly developed. The Dunn and Dunn Learning Style Theory (1972) is the most thoroughly researched of the various models. It is based on the following assumptions:

1) Most individuals can learn.

2) Instructional environments, resources, and approaches respond to diversified learning style strengths.

3) Everyone has strengths, but different people have very different strengths.

4) Individual instructional preferences exist and can be measured reliably.

5) Given responsive environments, resources, and approaches, students attain statistically higher achievement and attitude test scores in matched, rather than

mismatched treatments.

6) Most teachers can use learning styles as a cornerstone of their instruction.

7) Many students can learn to capitalize on their learning style strengths when concentrating on new or difficult academic material. (Dunn and Dunn, 1992, p. 6)

The Dunn and Dunn Learning style theory divides learning into five categories. These are environmental, emotional, sociological, physical and psychological. The environmental group consists of the student's response to sound, light, temperature, and formal or informal design. The emotional group consists of motivation, persistence, responsibility, and structure. The sociological group is made up of colleagues, self, pair, team, authority figures, and varied or mixed groups. The physical group includes perceptual modalities, intake of food or drink, and the time of day of instruction. The psychological group consists of analytic or global, hemispheric preference, and reflective or impulsive tendencies.

Dr. David Sousa, speaker and educator, explains that motivation, analytic or global,

and hemispheric preference account for eighty percent of the influence of learning styles He also explains that learning style loses its importance as the material becomes familiar. (Sousa, 1995)

Multiple Intelligences

Another way of looking at the learning process is through multiple intelligences. Howard Gardner (1993) has developed a theory based on the concept that intelligence is much more than that which is measured on an I Q test. Gardner has studied people of many ranges of intelligence from the gifted to the severely disabled. He initally identified seven intelligences at work in the human mind. The following is a list of each.

Linguistic - The ability to use language. Examples: poetry, reading, story telling, debating

Mathematical-Logical - The ability to use logic, numerical concepts, scientific thinking. Examples: measuring, organizing, calculating, deducting, analyzing.

Bodily-Kinesthetic - The ability to use movement and touch. Examples: Sports, drama, roll-play, field trips, creative movement, sign language, building

Visual-spatial - The ability to use one's vision and manipulate images spatially. Examples: Drawing, examining, visualizing, watching, seeking, sculpture

Musical - the ability to use rhythm, tone quality, volume, and pitch. Examples: Singing, listening, drumming, rhyming

Interpersonal - The ability to effectively make use of interactions between the self and other people. Examples: Collaborating, cooperating, leadership, negotiating

Intrapersonal - the ability to be aware of and use body states, emotions, intuitions, and spiritual awareness. Examples: Dreams, prayer, meditation, self-talk

None of these intelligence's exists in isolation, but rather interact with one or more of the other intelligences simultaneously.

Gardner speculates that there might even be additional intelligences such as *cooking*, which is based on the senses of smell and taste. Other possible intelligences could be *naturalistic, spiritual* and *ethical-moral.*

A Three Layered Brain

The Triune Brain Theory, developed by Paul MacLean, (1913----) reveals a three-part brain. In MacLean's theory, the layers of the brain are analogous to the history of evolution. It has been determined that with each successive evolution, the older brain was not replaced, but added upon. Each new layer adds a richness and complexity of function, yet retaining the former. The oldest section, the reptilian brain, also named R-complex, is mostly concerned with survival. The survival behaviors are territoriality, preening, nesting, maintaining social hierarchies, mating, flocking and deceptions. Behaviors associated with the R-complex are automatic, ritualistic and resistant to change. Although these are usually associated with animal behavior, the human

species *is* of the animal kingdom. There is a unique spin on these survival behaviors as they play out in the Homo Sapiens. The bulk of the R-complex is located in the brainstem. It may respond to language but does not use it.

The second brain to evolve is the limbic system, which includes the primary centers of emotion. The limbic system contains the hippocampus and the amygdala. The hippocampus is believed to deal with locale memory (the memory of locations) and the amygdala is thought to connect events and emotion. The limbic system is able to combine inner and outer experiences. Thus, it tempers the ritualistic behavior of the R-complex.

The youngest brain, in evolutionary terms, is the neo-cortex, also called the neo-mammalian brain. It is "creative, can use language, compose music and engage in complex analysis." (Caine, 1991, p.59) It plans for the future, thinks abstractly, and engages in formal operations. It is a vast, interconnected web of neurons. In the neo-cortex, there is no single site where a particular job is done, but rather a network of sites working together. The production of speech is an example. The movements of the tongue, lips, throat and lungs are choreographed in the motor area of the cortex. The words come from another site. Syntax, pitch and inflection come from still other locations.

Evidence suggests that if a newer section of the brain is defective, damaged, or threatened, the function of a particular locale will be taken over by an older area. As this happens, associated behaviors change. If the reptilian brain takes over, as it is designed to do, the individual will exhibit stereotypical patterns, fight or flight will

become more acute, repetitive activities dominate and thinking will be less flexible. If the limbic system takes over, emotional responses direct the activity. The three layers are redundant, each contributing to the survival of the species and the individual.

Somatic Marker Theory

The somatic marker theory was designed by Antonio Domassio (1994). Domassio presents evidence that emotion is an integral part of the thinking process, and not separate from cognition as previously believed. In Domassio's theory emotions highlight choices, simplifying decision making. Here, the brain's outer layer, the cortex, processes the information received through the senses, and an appropriate body response is elicited. This body state is enhanced through chemical messengers called neuropeptides, creating sensations like pleasure, pain, and anxiety. The brain reads and interprets the body state in terms of a mapped representation of the body. The memory of this event is associated with a feeling, sometimes subtle, at other times grand. As the memory is stored it becomes a marker, labeling the event for future reference as a positive, negative or neutral choice. In the future, when similar choices are to be made, there is an intuition, or "gut" response, which points towards certain choices and away from others. The somatic marker is a selection process which narrows the range of choices, facilitating decision making.

Much of this action takes place in the left frontal cortex. This was determined by studying individuals like Phinias Gage who suffered damage to his frontal cortex. Gage lived through a violent accident where a steel rod entered his cheek, passed through his eye socket and exited through his left frontal lobe. Even though he overcame tremendous

odds simply to have survived, he was no longer able to be the respected leader of his former days. He became an aimless drifter, unable to hold down a job for any length of time. (Domassio, 1994) Individuals with damage to their right frontal cortexes may have processed all the necessary information, and even know the correct procedures for good decision making. Even with all that abstract information, however, they are unable to choose well on a personal scale. Without a functioning somatic marker, an individual is likely to be immobilized by the range of possibilities and unable to choose, or he chooses badly, to the detriment of the self.

It is possible that an overactive somatic marker system may contribute to affective disorders such as panic attacks, obsessive compulsion, and depression by marking a memory inappropriately.

A Galaxy of Neurons

The mind and neural network are slowly and reluctantly giving up a few of their secrets. Each model that is developed, adds a new perspective to the multi-faceted landscape of the brain, with its many folds and structures. We have learned that the brain has first priority on available blood sugar. We know that the pineal gland, deep in the core of the brain, registers the amount and rhythms of light, setting the sleep and waking cycle and the energy level in response to seasonal changes.

In the brain, perceptual input goes through a series of processes through in order to become memories. They are the perceptual register, short-term memory, working memory and long-term memory. These are processes and not specific structures or

locations. The perceptual register screens incoming sensory input, sorting the relevant and dropping out the trivial. The short term memory evaluates what is important and focuses attention. The working memory manipulates thoughts, images and memories. Connections are made between thoughts, ideas, concepts, feelings and memories. New memories are created and stored, permanently altering the shape of the brain.

The vast, interconnected mind and body knows how to do what needs to be done to grow, survive, maintain, reproduce and repair itself. There are systems for taking in nutrition and sending a portion to every cell in the body. Information is taken in through the sense organs. The olfactory sense, taste, hearing, vision, moving, and touching systems each contribute a share to create an image of external and internal workings. A labyrinth of nerves, glands, bones, muscles, skin, and organs works together in complex precision. The immune system monitors a host of various benevolent and malevolent microscopic guests.

There are mechanisms for not taking in too much of the wrong "stuff". The mouth closes. The nose filters particles out of the air. The eye lids close. The ear can pick out a single voice from a backdrop of sound. Volumes have been written about each system; what it can do and what can go wrong. Whole libraries house details about these systems, and the variations and diseases which may occur.

The three- pound, three-pint, brain contains tens of billions of neurons that regulate cognitive activity. Ten fold are the number of glial cells that support, insulate and nourish the neurons. Thirty-thousand neurons can fit on the head of a pin, perhaps replacing the angels of the early philosophers. A dendrite, a sending or receiving

extension of a neuron may range in length from one millimeter to a meter. A single neuron may connect to thousands of other neurons. Current brain research suggests a plasticity of the brain; a brain that is continually renewing itself. Learning is no longer viewed as a simple storage of facts, but the making of connections and creating of meaning from experiences and information. The brain is understood to house many parts which work together. It is unified, holistic and highly interdependent.

The legacy of evolution has shaped who we have become and who we are now. Today, this legacy determines our evolution into the future, not in a fatally deterministic way, but by limiting our choices for future growth. This legacy can be expressed as **sensitivity to initial conditions**, in the language of non-linear dynamics. This means that even slight variations early on can add up to dramatic differences over a long period of time.

Chaos Concepts

The chaos theory, which describes observable patterns in chance occurrences, has applications for the study of the mind and its evolution. (Barton, 1994) Chaos gives a way of describing how we can all be the alike in so many ways. None of us are exactly the same in the way we perceive, process, store, retrieve, manipulate and communicate our experiences.

New applications of non-linear dynamics are currently being developed in neurobiology, psychophysiology, physics, chemistry and biology. Those who study brain wave patterns, how memories are formed, connectionist models of learning, heart rhythms, sleep patterns, population patterns, and genetics are finding self-organization a useful tool. In addition, approach-avoidance conflicts, coordination, family systems, and

conditioning in animals is also being studied through the lens of chaos theory. (Barton, 1994) The human brain is certainly worthy of being called a complex system, and subject to the rules of non-linear dynamics.

Dynamics is the study of how things change. Changes are either linear or non-linear. Linear changes are simple and can be modeled by one or two equations. The difficulty with linear equations is that they do not always describe what happens in the natural world. This is particularly observable when constant changes in controlling forces lead to sudden, extreme changes in behavior. For example, a steady increase of temperature will suddenly change calm, gently warming water into a bubbling, boiling broth. "This occurs in human psychological systems as well," (Barton, 1994, p. 6) report Kelso and Schoner, who study human movement. Try this experiment. On a desk or table, tap your right index finger, then the left finger. Continue alternating your tapping fingers as you gradually increase speed. There is a point at which your fingers will cease to alternate and tap in unison. When this happepns, a phase shift will have occured. "The speed of alternately tapping one's index fingers ... for instance, can be adjusted within a certain range of tapping speeds. However when the high limit of that range is exceeded, a sudden nonlinear jump to in-phase finger tapping occurs." (Barton, 1994, p. 6) Here non-linear concepts, although more complex, represent the real world more accurately.

A non-linear equation is difficult to solve. Often there is no single solution, but a pattern of solutions. "To find such a pattern, the data are generally run through a system of equations so that the results ultimately feed back into the system itself. ... This process is

called iteration." (Barton, 1994, p.6) Over time, most non-linear systems eventually settle down into one of four general patterns. These patterns are called attractors. They are (1) point attractors, (2) cyclical or oscillating attractors, (3) quasi-periodic attractors, and (4) chaotic attractors. The chaotic attractor is unique in that it is unpredictable. Its irregularity derives from the property of sensitive dependence on initial conditions. This means that, if two sets of initial conditions vary only slightly from each other, later states will differ widely, becoming more divergent over the passage of time. "Given that no measurement system is without some error, it becomes clear that if a system is chaotic, general patterns of future behavior may be predictable but specific behaviors over the long range will not." (Burton, 1994, p.6) Applying this concept to education, it means that we can statistically predict how a group will respond to a certain teaching strategy, but we cannot know what a particular individual will learn or remember.

The concept of self-organization links chaos to psychological systems.

> Self-organization denotes a process by which a structure or pattern emerges in an open system without specifications from the outside environment. When a system of this type receives a sufficient amount of energy, it may become unstable. As a result of this instability, an original uniform state can give rise to a variety of complicated temporal, spatial, and behavioral patterns. (Barton, 1994, p.7)

Self-organization aptly describes the development of the brain in the growing fetus. In the physical world, the Beluzhov-Zhabotinsky (BZ) chemical reaction illustrates self-organization. In the BZ reaction, "The system has the potential to exist in two different states," (Barton, 1994, p.7) one blue and the other red. If it is stirred, it will oscillate between these two states, changing from blue to red and back again about every 30 seconds. If it is allowed to sit, another type of organization appears. Any instability, such as a particle of dust or the touch of a pin, "triggers the formation of spiral or circular waves that propagate slowly throughout the system. ... If a faster wave overtakes a slower one, it will overtake it causing the slower one to disappear. This phenomenon is called entrainment." (Barton, 1994, p.8)

Self organization principles are:

(1) Bifurication, which is the potential for a rapid shift between a steady state and a chaotic state (Gleick, 1997)

(2) Multiple states that can change suddenly from one to another when a parameter value crosses a critical threshold

(3) Cyclical state changes

(4) The structural coupling of component processes

(5) Temporal, spatial, and behavioral organization

(6) Localized instabilities that can lead one part of the system to organize itself differently from another part of the system

(7) The ability of one unit to cause other units to oscillate at harmonically related frequency, (entrainment)

(8) Behavior that can sometimes be modeled by a system of non-linear equations

(9) (Other) self-organizing properties can only be found in living things. .. (Such as) the ability to develop stable yet flexible structures that serve important biological needs (Barton, 1994)

(10) Sensitivity to initial conditions (Gleck 1997)

Neurophysiologist Walter Freeman has used non-linear models to study brain function. He found that the memories of smells had a predictable spatial structure, which were not "fixed like a photograph. Instead the structure of old learnings reform in the context of more recent learnings." (Barton, Freeman, 1994, p. 9) This evidence of self-organization led to the conclusion that

> the initial conditions of the brain shift irreversibly every time something new is learned . ...What is truly extraordinary is that the process by which the brain creates memories can be similar in so many ways to the processes driving an oscillating chemical system. ... Through non-linear dynamics and a growing understanding of self-organization a whole new way of thinking about brain functions is beginning to emerge. (Barton, 1994, p.10)

To gain a foothold in working with such a vast concept, knowledge of the scale becomes a practical tool. It is useful to determine the size of our measuring device and decide what range of variation we are considering. In geography, the distance between the highest peak and the lowest trench would determine the scale of a map that would represent a cross section of these two natural structures. Making use of scale allows one to sort out the significant differences from the trivial. In each scale used, the measuring tool determines the outcome. A cartographer with a satellite map, working at a small scale, will determine a rocky coastline to have a certain length. The bicycle enthusiast will read a larger distance on his odometer due to the twists and turns and hills on the road. A hiker following the shoreline, scrambling over inlets and around salt marshes will travel an even greater distance. Finally, there would be an unimagined distance, if all the weathered cracks and tidal pools were measured, as an ant would travel.

In chaos theory, degree of scaling refers to the distance between the extreme highs and extreme lows of a system. It describes the difference between a landscape made of jagged mountains and deep valleys and the gently rolling hills of a countryside landscape. Scaling describes how a person can look at the bare branches of a tree in winter and tell if it is a maple, an oak or a willow. On an IQ test, the difference between the highest sub score and the lowest sub score determine the degree of scaling. The degree of scaling determines the final shape of an infinite number of distinct snowflakes.

> As water freezes, crystals send out tips; The tips grow, their boundaries become unstable, and new tips shoot out from their sides. Snowflakes obey mathematical laws of surprising subtlety, and it would be impossible to

> predict precisely how fast a tip would grow, how narrow it would be or how often it would branch. (Gleck 1987, p. 314)

This is analogous to how the developing fetus begins to grow the neural network of the brain. The general blueprint is laid out by heredity, but the actual twists and turns of the growing brain cells are already under the laws of chaos. The understanding of scaling aids in visualizing the workings of the brain. Within the brain there are systems; in each system there are sub systems, each sub system contains parts, and so on down to a microscopic level and beyond. It is possible that scaling is at the heart of personality, cognitive, behavior and learning variations.

The concepts of non-linear dynamics are new to the understanding of the processes of thinking and learning. They point to a universality in mental functioning. The seemingly immense differences, between the great minds and the minds of the mentally ill, may be simply a function of a slight variation of initial conditions, degrees of scaling, a bifurcation, or one of the other chaos principles.

In summary, the human mind is as complex as can be imagined. It is like a mansion with thousands of floors, windows, rooms, secret passage ways and hidden doors which open to other worlds. Like the blind men and the elephant, each theory describes a corner, but not the whole. All anyone can do is to illuminate the rooms of his or her experience. The chaos theory, high speed computers and recent developments in imaging technology offer a promise of new explorations, discoveries and insights. Perhaps we will never truely understand the whole. Yet as we reach for the infinate, we become more whole.

Chapter Two

Common Ground

There is an old wives' tale linking madness and genius. In reality, however, "research indicates that gifted students are more emotionally stable than average children." (Gallagher and Gallagher, 1994, p. 36) This statement, referring to the emotional stability of the gifted, ascribes to statistical norms and describes a representative child. However, not all gifted children are typical. As with any level of intelligence, giftedness can be paired with many types of personalities, learning styles and/or handicaps. The supposed link between mental instability and high intelligence is the exception rather than the rule, yet the so-called myth persists. Among the stereotypes are the "mad scientist," the "absent minded professor," and the math "whiz" with thick glasses. There may be a reason for this persistence, reflecting the title of this thesis. In this chapter, parallels will be drawn between the syndromes of (a) high-functioning autism, (b) gifted and learning disabled and (c) genius. These three very different populations overlap in striking ways.

This author proposes that there is a pattern of small but significant number of the gifted who bear a resemblance to sub-groups of both the learning disabled and the autistic. This could be the origin of the persistent myth. It is possible that these three overlapping sub-groups are manifestations of the same genetic heritage. It may be that the tendency for strong variations in certain cognitive functions is imbedded in that genetic heritage. This

could have given Homo Sapiens an evolutionary edge; since, after all, variation is the motor of evolution.

The Gifted, Learning-Disabled Learner

The Gifted Learning Disabled (GT/LD) population is a small percentage of school age students who have unique educational needs. Because of difficulties in identification, lack of programming, inconsistency in perceived student abilities, an overloaded delivery system, these students often have negative experiences in school. (Reis, Neu, and McGuire, 1995)

There is a small but rigorous amount of research that has been done on the GT/LD learner. Throughout this research, there is consistent evidence which supports the conviction that there are a set of common physiological characteristics which exist in this population. The research also supports the assumption that these learners need educational treatment which differs from the program available today in most gifted or learning disabilities programs. (Bireley, Langus, and Williamson, 1992) Their needs are met sporadically in the regular classroom as well. In many cognitive areas, the GT/LD population has more in common with gifted students than learning disabled students (Savage and Woodrum, 1989). GT/LD learners who have succeeded later in life report negative experiences in their schooling. However, they report strong parental support such as enrichment, advocacy, and emotional support (Reis, Neu, and McGuire, 1995).

Research of brain image patterning in the GT/LD population notes five tendencies: (1) higher cortical arousal than either LD or GT population, (2) delayed and asymmetrical

auditory patterns, (3) higher visual processing patterns, (4) stronger sensory processing modality strength for visual stimuli presented in color over black and white, (5) less frontal lobe activity. (Birely, Languis, and Williamson, 1992)

Identifying and providing for the educational and socio-emotional needs of the gifted student with a disability creates an interesting challenge. ... Careful plans must be made to attend to the needs of both the ability and the disability and to ensure the development of the self-concept of a person who is cognitively able as well as disabled. ... Planning teams may need to be innovative, flexible, and willing to try new ways of ... serving this small, but important, underserved group of the gifted." (Glenshaft, Birelely, and Hollinger 1995, p.213)

Twice Exceptional

To be gifted and learning disabled in the same body sounds like an oxymoron. In some ways it is. When two seemingly contradictory characteristics exist in the same person a dynamic tension is established. Sometimes the giftedness in a learner hides the disability and on the other hand, the disability hides the gifts. Often the disability creates stumbling blocks and only "dogged" persistence allows one to move forward. Some individuals learn to use the disability as a stepping stone. In learning to compensate, cooperate, and remediate, greatness can sometimes be achieved. A musically talented college student with learning disabilities reported that, in order to succeed, she had to do a superlative job. Nothing short of excellence worked for her. In developing the skills to overcome a learning disability, persistence is developed, strategies honed, priorities sorted and strengthened skills put into place.

Four famous individuals who were both gifted and learning disabled are Thomas Edison, Leonardo Da Vinci, Woodrow Wilson, and Hans Christian Anderson. (John Hopkins University, 1994) Each one of these eminent persons had to overcome a significant deficit in order to use his gifts. There are other men and women in the world who have risen to the challenge, and in the process have given great gifts to society as they have reached for their potential. Sadly, for every individual who succeeds in working successfully with his/her disability, there are others who are not successful and "fall through the cracks." Depression, financial insecurity, difficult relationships, frustrated talents and dead end jobs mark these people. This is a tremendous waste of potential and a drain for society.

Analogous traits

There is common ground between individuals who are gifted and learning disabled and those individuals who are high-functioning and autistic. Besides high intelligence, members of both groups share uneven skill development, perceptual anomalies, and difficulties in communication. Autism is a syndrome, or a collection of symptoms. When unusual sensory processing, social incomprehension, compulsive behavior and serious communication problems exist together in one body, the person who inhabits that body is labeled autistic. "Think of the components of autism ... as colors on a child's palette. Different mixes of red, blue and yellow produce a rainbow of hues. Similarly, different combinations of autism's components produce an array of conditions known by the umbrella term autism." (Newsweek, 1996, p. 70)

While differing in outward appearance, the syndromes of high functioning autism and GT/LD have striking similarities when described in general rather than specific terms. An example of this is in the use of language for communication. Both populations display communication difficulties. The person with autism has difficulties understanding and using spoken language. The person with learning a disability has language difficulties in one or more areas such as written language. The Michigan State Board of Education describes the student with learning disabilities as having

> a severe discrepancy between achievement and intellectual ability in one or more of the following areas: (a) oral expression, (b) listening comprehension, (c) written expression, (d) basic reading skill, (e) reading comprehension, (d) mathematics calculation, (g) mathematics reasoning (State of Michigan, 1994, p.10-11).

Remember, mathematics is a form of communication and has its own language. In reference to language, the State of Michigan describes autism as including "an absence, disorder, or delay of language, speech, or meaningful communication." (State of Michigan, 1994, p.12) Using specific wording, autism and learning disabilities appear to be quite different. Taking a longer view with broader language, both syndromes include difficulties in communication. Note that many individuals with autism also have learning disabilities. In chaos terminology, the difference is a sudden non-linear jump along the communication continuum. The difference between having learning disabilities with some autistic-like traits and full-blown autism, is like the difference

between flowing water and ice. In other words, it is a steady state which can change suddenly from one to another when a parameter value crosses a critical threshold.

There are other overlapping areas between the two groups. Abnormalities in sensory perception are prevalent in both learning disabilities and in autism. Functioning with inconsistent, distorted and incomplete information faces the people with autism from moment to moment. Sensory anomalies contribute to the confusion of the learning disabled. On the positive side, artists, musicians, writers, often perceive the world in ways differing from the average person.

Social difficulties are a hallmark of autism also many persons who have learning disabilities also have social difficulties including shyness, and gaucheness. Interestingly, gauche is French for left-handed. (Left handedness is often associated with a right hemispheric preference, and/or mathematical talent or deficits.) At times in history, left handed people have been treated cruelly, as have individuals with autism.

While autism can have multiple causes, experts accept that there is a degree of inheritability. It would follow, then, that if there were a sub-group of the autistic who receive their disability through genetics, then, the relatives of those people would display a similar collection of symptoms. Temple Grandin has documented such a phenomenon.

Temples' View

Temple Grandin is a remarkable individual. With a Ph.D. in animal science, she has designed one third of all the livestock handling facilities in the United states and in many other countries. Roger Caras, President of the Society for Prevention of Cruelty to Animals writes, "Temple Grandin , an icon in the world of animal welfare, is in fact an alien from another place. She has come here from the almost unimaginable world of autism and has seen both us and herself in a wonderfully new and lucid way." (Grandin, 1995, Jacket Cover) Temple was born with autism and brings an important perspective to the discussion of autism.

In addition to her work in as Assistant Professor of Animal Sciences at Colorado State University, she has written numerous articles and two books on autism. Her second book, Thinking in Pictures, is the work of a mature author and well worth the reading. In the forward, Oliver Sacks writes,

> Here we can see and re-live, what it was like for Temple as a child ... the overwhelming sensations of smell and sound and touch she could not block out.... We seem to acquire with her, the first, inchoate beginning of speech, the sense of language as an almost miraculous power by which she might gain some mastery of herself, some contact with others. ...We can share ... her extraordinary passion and understanding for cattle which have made her ... a world-renowned expert on cattle psychology and behavior, an inventor of devices and facilities of handling them, and a passionate advocate of their humane treatment. ... And we get a glimpse of her total bewilderment about

> other peoples minds, her inability to decipher their expressions and intentions, along with her determination to study them, to study us ... scientifically and systematically. (Oliver Sacks, Forward of Grandin, 1995)

The gulf between autistic behavior and non-autistic behavior is very wide. Through Temple's desire to make sense of what is for her an alien place and her desire to communicate, she has given society a valuable gift. She has brought to light our shared humanity and has shown us that the gulf is not as wide as we thought. She has built a bridge.

Familial Traits

Leo Kanner and Hans Asperger led parallel lives. Both were born in Austria, and trained in Vienna, yet never met each other. "By a remarkable coincidence, Asperger and Kanner independently described exactly the same type of disturbed child to whom nobody had paid much attention before and both used the label autistic." (Frith, 1991, p.6) Asperger was more interested in the subtle, milder, traits in high-ability children. Kanner was interested in the more dramatic features that were often accompanied by mental retardation. It is now believed that autism exists on a continuum, ranging from Kanners' to Aspergers' syndrome. Perhaps the continuum does not end within the boundaries of these syndromes, but continues to range to a lesser degree into learning disabilities, and into genius.

> Many researchers speculate that a cluster of interacting genes may cause a variety of disorders such as depression, dyslexia, schizophrenia, manic-depression, and learning disabilities. ... They also maintain that many

> disorders such as depression represent extremes of a continuum of behavior from normal to abnormal. The same genes are responsible for both normal variations and abnormal extremes. It is likely that the same principal applies to autism. People labeled autistic have an extreme form of traits found in normal people. (Grandin, 1995, p.177)

With the accumulated evidence which is presented in table one, we find ourselves face to face with the stereotypes where we began this chapter.

Table 1

Evidence Supporting the Genetic Linkage of Pairs Traits: Giftedness, Visual Thinking, Creativity, Learning disab ilities, Allergies, Affective disorders, Handedness, Autism and Asperger's Syndrome

Traits	Description and Source
Clusters of traits:	Temple Grandin reports anecdotal and researched evidence of a connection between giftedness, learning disabilities and autism. Through her many conversations with family members of individuals with autism, she has discovered that often, relatives of the autistic are intellectually gifted. In addition, she has learned that within the family histories, there is a high incidence of individuals with learning disabilities, depression and allergies. She notes "that many parents of autistic children are visual thinkers with talents in computers, art and music. Other common traits in the family histories of austistics are anxiety disorder, depression and panic attacks." (Grandin, 1995, p.1776)
Familial Linkage	G. DeLong , Division of pediatric Neurology, Duke University Medical Center and Judith Dwyer, Department

of Neurology, Tufts New England Medical Center, have concluded that a large proportion of high-functioning individuals within the autistic spectrum have a positive family history for an autistic-like personality disorder (Asperger's syndrome) ... These findings suggest that high- and low-functioning autism are, in general, different conditions. According to this formulation, high-functioning autism is generally a familial condition .... and low functioning autism has a much larger factor of neurological damage. ... This suggests that high-functioning autism and Aspergers syndrome are in part equivalent and have a predominantly familial etiology.

Familial linkage

Dr. Edward Rivito from UCLA describing genealogical studies, " found seventy families in the United States ... that reported more than two cases of autism among their relatives. His research showed that at least one form of autism appeared to have a familial or genetic pattern." (Hart, 1989, p. 209)

Traits of Family Members

Narayan, Moyes and Wolff studied characteristics of family members of autistic individuals. They looked for the appearance of mildly unusual personality features. These are "social gaucheness and a tendency towards the

single-minded pursuit of special, often intellectual, interests." They report, "It has been our impression that the personality features we identified in the parents of autistic young people, while real, are quite subtle and more easily recognized in the fathers than the mothers. Within the 21 families in the study, only one set of parents was not identified as definitely not presenting these characteristics. It is interesting that these families were characterized by their relatively high social status."
(Narayan, Moyes, and Wolff, 1990, p. 528-529)

Family Traits

DeLong and Dwyer report: "The results showed a high incidence of Asperger's syndrome in family members of high-functioning autistic subjects only, (and not the family members the lower functioning subjects.)

Genetic Linkage

In a study of identical twins, Folstein and Rutter documented that "when one twin was autistic the other twin was autistic 36% of the time." (Grandin, 1975, p. 177) The rate in the general population is .0015%.

Learning Disabilities

In the same study, among the non-autistic twins, there was a higher percentage of learning problems than in a twin control group.

Affective Disorders	DeLong and Dwyer report; The rate of bi-polar affective disorder in family members was 4.2%, higher than in the general population; it was significantly higher in families with asperger's syndrome, suggesting an etioneurological link between Asperger's syndrome and manic depression." (DeLong and Dwyer, 1988, p 593)
Affective Disorders	Lorna Wing, a ground-breaking researcher in the field of autism, followed a group of individuals with Aspergers syndrome through puberty. She found that 23% showed signs of affective illness. (Wing, 1985)
Affective disorders creativity	Dr. K. Jamison has documented a link between manic depression and creativity. In Touched By Fire, she writes, The basic argument of this book is not that all writers and artists are depressed (many are not) but that a greatly disproportionate number of them are; that manic-depressive and artistic temperaments are, in many ways, overlapping ones; and that the two temperaments are causally related to one another. The genetic basis of manic-depressive illness provides not only one part of this argument, but also the constitutional core of a determining temperament, one providing in part the

	sealed orders with which so many sail. (Jamison, 1993, p. 237)
Affective disorders Creativity	A study published in the American Journal of Psychiatry, by N.C. Andreason showed that "80 percent of creative writers have a mood disorder at some time in their life. A high percentage of artists, poets, and writers have to take medication, and 50 percent of poets had to receive treatment. ... (The study) also showed that parents and siblings of writers have a high rate of mood disorders." (Grandin, 1995, p.178)
Associated traits	In Trends in Neuroscience, C.B. Persson reported that several characteristics occur more frequently in mathematicaly gifted people. "There is a high correlation with physical abnormalities. In addition, both learning disability in mathematics and math talent are associated with left-handedness. Young children who show very high in verbal reasoning and mathematics are twice as likely to have allergies as the rest of the population. Students with extremely high ability are also more likely to be nearsighted." (Grandin, 1995, p. 179)

Eminence within Autism

It follows that if there is a link between giftedness and autism, there should be a group of famous, and/or gifted, high-functioning autistic individuals. This information is difficult to uncover. People who have made significant contributions, and who also have autism are hidden, if they are there at all. There are several reasons for this. Autism, and the overlapping Aspergers syndrome, were not described as disorders until the 1940's by Leo Kanner and Hans Asperger (Frith 1991). This means that no one with historic significance could have been diagnosed. For many years after, only the people with the severest traits were diagnosed. This excluded the higher-functioning autistic. In addition, there is the issue of confidentiality. Respect for an individual's privacy and concern over public response keeps most high-functioning individuals "in the closet." And of most consequence, because of the inherent characteristics of autism itself, people with autism rarely seek the spotlight, or choose situations that would put them in the public eye. Temple Grandin, however, is not alone as a gifted, autistic individual, who has emerged in the spotlight. Donna Williams, an English woman with autism wrote two introspective and powerful books sharing her growth, her struggle to make sense of her life, and her discovery and exploration of her own autism. The titles, *Nobody, Nowhere* and *Somebody, Somewhere*, have appeared on best-seller lists. Also, Bill Gates, of Microsoft fame, posesses a convincing number of typical autistic traits. These traits include poor social skills, repetitive rocking, and minimal eye contact (Time, 1994, p 25)

Other famous people who have displayed autistic/Asperger traits are the philosopher Ludwig Wittgenstein, artist Vincent van Gogh, and the famous name that appears on every list of geniuses with special characteristics, Albert Einstein. It is interesting that Einstein's second cousin has two children, one who has autism and another who is intellectually gifted.

From here, we speculate. It is said that a certain socially immature chess champion is autistic. It is also said that a rival of Thomas Edison, who invented the fluorescent lamp, was autistic. A case could be made for Mozart as having many characteristics of Asperger's syndrome. Johnny Appleseed flapped his arms as he strolled the American frontier, planting apple trees and repeating Bible stories, preferring the company of animals to his fellow humans.

In the past, many children with autism were thought to have been raised by wolves. The Wolf-Child of Aveyron is one such a case (Lane, 1976). Perhaps Rome founded by a pair of high-functioning autistic twins. The common autistic trait of fixating on spinning objects may account for the creation the first prayer wheel of the Tibetan monks, spinning endlessly, sending prayers to the Almighty. In some African tribes, every once in a great while, a child is born who has the ability to memorize the immense genealogy of the group. Who but the autistic would be better suited for this kind of profession? Likewise, an autistic person who had calendar skills may have been involved in the making of Stonehenge.

Autism and Asperger syndrome, although fraught with difficulties, are not without their

positive sides. Hans Asperger, the physician who first described Aspërger's syndrome,

> pleaded for the recognition of such (autistic) children, pointing out the potential they had to offer society. ... He also suggested parallels between autism , scientific originality and introversion. As a classicist he was undoubtedly influenced by Seneca's famous words that there is no genius without madness. While this idea has been with us for centuries, it is only now that we are considering that the madness in question may be autism.
>
> Asperger's views on the positive value of autism as an important aspect of creative thought and intellectual style are still fresh and provocative. .... There is no getting around the fact that autism is a handicap. Even the best-adjusted ndividual with Asperger syndrome has more than the usual share of problems. (Frith, 1991, p. 32)

In her article, *Asperger and His Syndrome*, Uta Frith concludes,

> Like Asperger, I would sometimes like to claim a dash of autism for myself. A dash of Autism is not a bad way to characterize the apparent detachment and unworldliness of a scientist who is obsessed with one seemingly all-important problem and temporarily forgets the time of day, not to mention family and friends. True to the recursive pattern of thought, it is possible to conclude

that an appropriately never-ending subject for such a single-minded interest could be Asperger's syndrome (Frith, 1991, p. 32).

Hans Asperger himself writes,

> The skills that a child acquires, grow out of a tension between two opposite poles: one is spontaneous production , the other imitation of adult knowledge and skills. They have to balance each other if the achievement is to be of value. When original ideas are lacking achievement is an empty shell: what has been learnt is merely a superficial and mechanical copy. Autistic intelligence is characterized by precisely the opposite. Autistic children are able to produce original ideas. Indeed, they can only be original, and mechanical learning is hard for them. They are simply not set to assimilate and learn an adult's knowledge. Just as, in general, someone's good and bad sides are inextricably linked, so the special abilities and disabilities of autistic people are interwoven (Frith, 1991, p. 70).

Asperger continues, presenting a seeming contradiction to the communication disorder at the heart of autism.

> They, and especially the intellectually gifted among them have a special creative attitude toward language. They are able to express their own original experience

> in a linguistically original form. This is seen in the choice of unusual words which one would suppose to be totally outside the sphere of these children. . . . For example, we can mention a six to seven-year-old autistic boy who defined the difference between stairs and ladders as, "The ladder goes up pointedly and stairs go up snakedly" (Frith, 1991, p. 71).

Rafael, a teenager with autism wrote the following poem:

The sun is an owl's eye,

Staring at me through

The fog.

This raises the question of how a person with a language disability, who has a great difficulty communicating, can be so poetic. It is possible that part of the answer may lie in the chaos concept of scaling. Because the major communication system is damaged, it does not necessarily follow that all communication systems are damaged. Smaller sub-systems may be intact. Where language-as-communication may be damaged, a secondary system of language-as-creativity could be strong. As mentioned earlier, when one system is not functioning, the redundant brain has back up systems that take over the job. In the autistic population one may observe qualities associated with the R-complex such as ritualistic activities and resistance to change. This could explain one of the most puzzling aspects of autism that being creativity and resistance to change inhabiting the same person.

Neurology and Autism

Neurological studies of the brain of the autistic are relatively new. There are intriguing possibilities. Some limited research has been accomplished. There are some neurological differences in the brains of individuals with autism as compared to the general population.

> Dr. Margaret Bauman from Boston's Children's Hospital reported dramatic differences in the brains of autistic people who died. Her autopsies showed that certain groups of cells, called Purkinje cells, were abnormal. Her subjects had less cells than normal individuals, and those cells were smaller and less mature than they should be (Hart, 1989, p. 208).

The cortex of the cerebellum is made up of three layers, the granular (inner) layer, the perkinje (middle layer) and the molecular (outer) layer. The purkinje layer has the thickness of one cell and contains only one type of cell. It is shaped like a bushy plant such as baby's breath or tumble weed. The many dendrites branch repeatedly at right angles, comming together in a single bottle-shaped stem, or cell body. A single root or axon passes through the inner granular layer, "enters the white core of the folium, and terminates in one of the central nuclei" (House and Pansky, 1960, p. 315). One or two branching dendrites enter the outer molecular layer. Scientists think that the purkinje cells integrate information from the various sensory system .

In a study measuring the speed of processing of audio and visual signals from the brain, psychologists from the Staten Island Neurological research Center found differences between the autistic and general populations.

> They discovered that the rate of passing of messages from eyes and ears to the brain varied widely among autistic children. Some showed serious delays in processing information. For some, the rate of response stayed the same during different periods of testing, but others had unusual patterns. The delay between sight or sound and the child's brain receiving the signal changed with every testing. For the children tested ... sights and sounds were never coordinated. Their world was like a movie with the sound track out of synch with the picture (Hart, 1989, p. 207).

This trait is shared by both with the autistic and the learning disabled.

Eric Courchesne and colleagues studied the cerebellum of individuals with autism with Magnetic Resonance Imaging (MRI). He found that the motor areas of Cerebellar Vermain Lobes VI and VII were either hypoplastic (smaller than average) or hyperplastic (larger than average). This reinforces the notion that there is more than one cause of autism. Through earlier work they determined that this area was more than just a motor area. They found evidence that this area regulates the switch from one modality to another.

> By studying patients with a damaged area of Vermain Lobes, it was

> determined that neocerebellar activity may affect the ability to rapidly and accurately move or shift the "spotlight of attention" from one source of information (e.g., auditory) to another (e.g.,visual) but may not affect the ability to maintain attention on only a single source for long periods of time (Akshoomoff and Courchesne, 1992, p. 731).

The tendency towards single-minded persuits may be a result of this variation. Compared to other fields, the research into autism is relatively new. Autopsies are rare occurrences, which make it difficult to document strands of differences.

Today, the state of research on autism is similar to to the state of research on "dementia" several decades ago, when the umbrella term "dementia" encompassed several subtypes of dementia resulting from different causes. Future study will very likely divide autism into more specific biological and eventually etiologic subtypes (Hart, 1989).

An Arrangement of Genius

It is impossible to say that genius is normal. Although it is highly desirable, it is a very rare condition. Only about one percent of the population qualifies. "It is likely that genius is an abnormality. If the genes that cause autism and other disorders such as manic-depression were eliminated, the world might be left to boring conformists with few creative ideas." (Grandin, 1995, p. 178) The common thread amoung these conditions may be a pattern of uneven development.

Autistic savants, like the character Raymond in the movie Rainman, often display amazing strengths in narrow areas of functioning. Although these splinter skills are dramatic, they are rarely practical. After all, of what use is it to have the telephone book memorized, and not have the social skills to make a phone call? Occasionally people with autism develop a splinter skill to the point of its being an actual talent. Piano tuning, sculpture, drawing, and chess are among the examples. Many individuals with autism have highly developed visualization skills. Temple Grandin (1995) is able to "test" her architectural ideas by manipulating them in her head. In this way, she has come to practical and innovative solutions.

If one views the splinter skills of the autistic on continuum, expanding slowly to become talents in people who are less disabled, one can accept the point of view that smaller doses of autistic-like traits contribute to the making of a creative genius.

In the Termain study, a group of children with extremely high IQ scores were followed throughout their growing up years. This longitudinal study has revealed that, although there are many highly successful people in this group, there is a noticeable absence of creative geniuses. From this we can surmise that there is more to intelligence than IQ (Goleman, 1960).

Many characteristics that accompany high functioning autism, Asperger's syndrome, and GT/LD syndrome, are observable to varying degrees in the creative genius. Among these are (1) persistence, (2) seeing the world in unique and unusual ways, (3) use of less common forms of communication, (4) single-minded pursuits, and (5) resistance

to pressure to conform. In manageable doses, they are all excellent qualities to embody and to support the work of a creative genius.

Uneven development is another hallmark of the three overlapping populations of GT/LD learners, autistic and the genius. Where the unevenness contributes to less desirable characteristics in the first two groups, the unevenness contributes in a positive way to the making of a creative genius. This is not an either-or situation, as all people have a mix of both positive and negative traits, depending on the context. It may be that the tendency to unevenness in neurogical development is inherited. It is the lucky ones who end up with a bulk of useful variations. Neurological variations, and the tendency to developmental extremes is a descriptor that applies to all three of these groups. This brings us back to the chaos theory.

It is likely that there is an ancient gene pool spread throughout the species where *variation* is dominant. It is impossible to predict which particular variations and which strength will occur in any particular child. Yet we can say with reasonable certainty that these individuals will exhibit neurological extremes. This genetic wild card has contributed to making the human species what it is. Perhaps giving us an evolutionary edge over the other early primates.

An abundant future is dependent on our making the most of who we are as individuals and as well as a species. We have chosen a path where we have eliminated predators and where the disabled survive to reproduce. In our new world, we have taken the evolution of our species into our own hands. We make decisions that determine our future evolution as a species without knowing how the pattern we set in motion will play out.

We must keep in mind that variation is the motor of evolution. Through sensitivity to initial conditions, we have set forces in place the result of which we cannot yet guess or imagine.

Chapter Three

Translating an Image into Words

This chapter is a fleshing out of the underlying assumptions behind this paper. It is putting intuition into words. It hangs on beliefs; it is built of experiences. It is a reflection of a democratic view of the intrinsic worth of all people. It is the uncovering of the bones of a theory.

At the heart of this theory are the interaction and balance among three qualities. They are (1) **self-mastery**, the **(2) need to invent,** and the (3) **ability to communicate.** These qualities exist in everyone in varying degrees and proportions with most people having an ordinary balance of each. An assumption has been made that the distribution of each quality follows a bell-shaped curve. Thus, few people would exhibit extremes and there are strong differences between those individuals who do. Whereas the people who display less extremes, would be abundant and more similar to each other.

Self-Mastery:

Self-mastery is, in essence, the ability of a person to be in charge of his/her life, thinking, and learning. Self-mastery is to be the captain of one's own ship. Self-mastery builds self-confidence.

In a classroom, the student who is high in self-mastery is the student who is self-directed and able to use the teacher as a resource. That student is trustworthy,

responsible and independent. The teacher's role is to be a resource and a guide. Self-mastery is related to and parallels intelligence, although it is not the same.

A person who is low in self-mastery needs a different environment in which to function within the classroom and other social institutions. This person needs strict controls, immediate rewards and/or punishments in order to succeed. This extreme is often associated with lower intelligence, but not always. In between these two extremes lies a continuum. The expression of self-mastery may be "across the board," it may be related to specific skill areas, or it may be situational.

In the GT/LD and high functioning autistic group, there is a pattern of uneven skill development. Many of these individuals fluctuate widely in self-mastery, depending on whether that person is operating out of a strength or weakness. This can be confusing to the individual, teachers and others who interact closely. It is important for teachers to see that these learners have ample time to exercise their strengths, in addition to systematically improving their deficits.

Communication:

The ability to communicate is at the core of what distinguishes us as a species. Communicating thoughts and ideas accurately empowers the communicator. Spoken language is the dominant form of communication among humans. Written language and other visual symbols are a close second. We have the capacity to communicate through other forms as well. Touch, movement, posture, signs, music, visual art, sign language, perfumes, cuisine, mathematics, technologies are among the many other forms of communication.

If a person has a weakness in a primary mode of language, secondary modes may emerge as strengths. When a person relies upon and develops secondary modes of communication, they emerge as talents only if there is an appreciative audience. Without an understanding audience, the secondary modes are seen as bizarre, eccentric, or idiosyncratic.

There are sub-skills within spoken language. Pitch and inflection, the reading of faces, the understanding of syntax, are a few. The ability to imitate is a major tool of learning, and a source of much enjoyment. Without the flexibility of normal communication, the ability to imitate becomes the seemingly meaningless parroting or echolelia, characteristic of many autistic people. Yet, a person who is alert and aware, may be able to interpret the meaning intended in echoelia. Most people have a strong, central spoken language, a supportive written language, and varied lesser modes. Very lucky indeed is the person who has many communication strengths.

Invention:

The need to invent is the third component of this theory. The word "inventive" was chosen instead of the word "creative". In some cases the two are interchangeable. However, "invention" seems to be the essence of what the author is attempting to communicate. The word, "creativity" brings with it many extraneous associations, muddling the message.

In this context the need to invent, is a force which drives a person to create. It is not always a choice. Sometimes, it is a path that a person *must* walk in order to learn about and make sense of the world. The inventive person is the one who learns through a blend

of imagining and creating. The inventive person carves a path where there was none before. It is possible, that the need to invent is fueled by memory deficits.

Being inventive is much more than being a kinesthetic learner, someone who learns by doing. Invention is a learning style in and of itself. It is essential that the person who is high in the need to invent create. In inventing, he/she discovers the "what and why" in order to make meaning. This process is time consuming, and frequently inconvenient in the classroom. This puts the inventive learner at a disadvantage. The highly inventive learner has to approach new information in a creative way for understanding to occur. In other words, an original product or original thinking is the necessary first step in the making-of-meaning process.

To illustrate, Kerry, a very inventive person, had difficulty using a filing system. He designed a personal filing system and put it to use. Through the process of invention, he is now he is able to recognize, judge and appreciate a commercial system. Before the inventing of the alternate system using the popular product was a meaningless encumbrance, imposed from without.

The highly inventive person may have difficulty in relationships. To live in close contact with a person who never "goes by the book" is exasperating, and places a strain on a relationship. To be that person who must continually re-invent his/her world is a study in patience. Yet, to invent is to remember, to remember is to learn.

Postulates

As inventiveness, communication ability, and self-mastery interact, an underlying pattern is uncovered. The following list of traits are consistent for all three qualities.

1. Strengths and weaknesses can either be "across the board," situational, or limited to sub-skills.

2. In abundance, the three qualities combine in an exponential way, to build a gifted, highly functional person.

3. Two strengths in combination with a weaknesses is still valuable, yet the person is less likely to develop to his full potential.

4. A single strength in combination with two weaknesses, becomes less useful, leaning towards eccentricity and splinter skills.

5. The strength of each quality is subject to environmental pressures, instruction, situation, genetic make-up, and the affective domain.

6. These characteristics are not the same as, but parallel intelligence.

7. Age and maturation tend to improve the strength of each of the three qualities.

8. Forces that degrade the three qualities include brain injury, disease, distressed emotional state, depression , addiction, abuse and violence.

9. Each of these qualities can be strengthened in most people.

10. An unevenness of sub-skills within a particular quality is common among the GT/LD, high-functioning autistic and creative genius populations.

Types

A typology is like putting a photograph of a face through a copy machine. The result is recognizable, but definitely not a true likeness, this analogy is useful to keep in mind. This representation exists for the purpose of organizing and "chunking" information, so that it may be more easily visualized and mentally manipulated. It brings with it the hope of opening a window on our commonality.

There is an infinite range of combinations and degrees of variation possible within this model. If the extremes and absolute "normal" are taken into account and the ranges in between, eliminated, there are nine possible combinations or types. In the following listing, "I" stands for invention, "M" for mastery, and "C" for communication. The plus or minus before the letter represents extremes in the occurrence of (+) or the absence of (-) the quality. The absence of a plus or minus sign refers to an average strength of the quality. This listing describes natural abilities and disabilities and does not take into account the variables of environment, situation or affect.

- IMC; This represents a person who is average in all three qualities. He or she is a well functioning person, someone who works hard in school and does just fine. There are many people in this group.

- +I+M+C; This represents a person who is high in all three qualities. He or she is wonderfully gifted, a great communicator, strong in self-mastery. and highly creative. Here, we find people like Carl Sagan, Oprah, Eleanor Roosevelt, and Abraham Lincoln. The world would be a much poorer place without the presence of people like these.

- -I+M+C; This represents a person who is a great communicator, strong in self mastery and low in creativity. A person like this would do well in an institutional hierarchy. Successful religious leaders, army generals, school superintendents would likely be -I+M+C. Here we find people like General Powell and Robert Dole among others.

- +I-M+C; This represents a person who is high in creativity, low in self-mastery, and high in the ability to communicate. These people are often colorful. They embody the ingredients of a Shakespeare tragedy, a hero for whom a character flaw could potentially bring about his or her downfall. Here, we find Ernest Hemingway, Elvis, Maryln Monroe, Edward Kennedy, and possibly Bill Clinton.

- +I+M-C; This represents a person who is high in both creativity and self-mastery, and low in communication skills. This person may spend years developing an alternate form of communication. Albert Einstein, Glen Gould, Emily Dickenson, Sigmund Freud, Newt Gingrich typify this group. Some people with Asperger's syndrome may belong to this group.

- -I-M+C; This represents a person who is a great communicator but low in both self-mastery and creativity. This person may find his expression in convergent, black and white issues where there is a narrow point of view, and only one correct answer. Here we find a "con-artist." Perhaps Adolph Hitler falls into this category.

- +I-M-C; This is a person who is inventive, but poor in both self-mastery and communication. These are talented people who never seem to get any where. A person of this type may have a string of failed businesses. This is where we find many

individuals with autism, as well as many people with learning disabilities. Names are not associated with this group as unless they can build at least minimal skills in communication and self-mastery, they will remain obscure. In overcoming these disabilities, though, one has to strengthen both self-mastery and communication skills. Those who are successful, move into the +I+M-C or +I-M+C group.

- -I+M-C; This represents someone who is neither inventive, nor much of communicator, yet exhibits excellent self-mastery. This person might be a yogi desciple, a "B" student, a good soldier or a good corporation employee. These people rarely become famous. Perhaps the fictional character Forrest Gump typifies this group.

- -I-M-C; This represents a person who has little self-mastery, little inventiveness, and little in the way of communication abilities. This person is not particularly functional, and possibly mentally retarded. Without a strength to rely upon, it becomes very difficult to improve these three areas. This person requires external structure, and outside guidance to become functional in school and the larger society.

Violence and Creativity

It is important to differentiate between the inventiveness embodied in the +I person, and the invention that arises out of a sense of threat. It could be argued that Hitler was very inventive. However, in this typology, he is in a -I group. Although the Nazi death camps and the multitude of weapons of destruction could be viewed as inventive, actually this is a limited expression of inventiveness.

Violence either comes out of a sense of threat and the viewing the world in terms of only extremes, where there is only right and wrong and no shades in-between. According to MacLain's triune brain theory, the R-complex can be very inventive when it comes to protecting itself. This is not the same as being an inventive person. The R-complex is mainly concerned with survival. The inventiveness that comes with creativity uses the frontal cortex to imagine an range of choices. The world of the creative person is not seen in black and white, but in a spectrum of colors. Violence is a single-answer, narrow-minded solution. True inventiveness is open-minded, divergent, and draws inspiration from diversity .

Some people can move from the narrowness of violence to wide-eyed creativity. Teachers can facilitate this by teaching students to use anger as a "red flag" signaling a problem to be solved. This process of reflection and creative problem solving can make one's life more functional. Anger becomes a marker for where attention needs to be paid, as opposed to a signal for thoughtlessly, leaping into knee-jerk, volatile expression. On the other hand, the creative process is a paradox because creativity always includes the destruction of one thing to make another thing. This emphasizes the desirability of fostering the companion qualities of responsibility and self-mastery.

Strategies for Education

As modern humans grow and mature, an immense piece of time is spent in institutions of education. If the time is well spent, much can be accomplished. If the experience is damaging, serious harm can be done to the learner. Because the purpose of education is to prepare one for later life, it is wise to reflect on the process.

Educating all learners is a monumental, time consuming task. The few high functioning autistic, GT/LD and the highly gifted require time and energy sometimes at a cost to the many students who make up the bulk of the classroom. Some strategies may improve the situation. Those who hold the bulk of the power are administrators, teachers, parents, and to a lesser degree, the students themselves. In education, there is a strong trend towards mainstreaming. This presents an immense challenge where there are children with strong, sometimes conflicting needs, in the same setting. Complexity reins. There are no simple solutions. Perhaps someday we will know enough to create a safe, positively stimulating learning environment to educate the whole of each child. Until then, our best is the art of teaching and the wisdom generated by generations of educators.

Just a few years ago, chaos was merely the playground of artists. Potters took pleasure in how the glaze in how each raku pot showed differently as it came from the fire. The difference between a masterpiece and a reject could be a minute variation in the temperature of the firing or of the minerals of the clay body. Painters would observe contrasting colors forming plumes and eddies before drying in their final position on the paper. Now science has entered this exploration. Perhaps it will be the same with education. It is only in the past few years that we have glimpsed the actual making of memories. Now we have opened a window on the workings of the mind and the body with which it interacts. Perhaps it is not a question of changing the educational system for the better, but how to steer through the turbulence of certain change.

What Students Can Do

(1) Learn about your preferred styles of learning.

(2) Learn how to ask for what you genuinely need.

(3) Tolerate and respect differences among others.

(4) Learn communication, diplomacy, and negotiation tactics.

(5) Be curious.

(6) Turn off the TV.

(7) Explore and create, learn hard stuff.

(8) Make lots of mistakes, and learn how to learn from them.

(9) Let go of wanting to be perfect and learn how to be content with the unique person you are.

(10) Believe in your strengths.

What Parents Can Do

(1) Volunteer in the classroom.

(2) Create a structured, enriched environment in the home.

(3) Learn about the various theories of the mind.

(4) Develop skill in advocating and diplomacy.

(5) Role model what it is to be a life-long learner and share in the joy of learning.

(6) Learn to recognize signs of depression.

(7) Limit TV.

(8) Cultivate a taste for quality.

(9) Develop relationships with mental health professionals before a need arises.

(10) Ask for help.

What Teachers Can Do

(1) Use Pyramid Planning, a visual organizer which helps to prioritize information to be learned. The base layer represents the information, concepts and ideas that all students should learn. Not just factual but include higher order thinking as well. The second layer represents what most, but not all students will learn. These are additional facts, concept extensions and related or more complex concepts. The top layer represents information that only some students will acquire. This information is incidental to the concepts or content presented in the lesson. (Schumm, Vaughn, Leavell , 1994)

(2) Teach independent learning strategies.

(3) Teach units of high interest, targeting GT/LD learners.

(4) Teach organization skills to all students.

(5) Team teach.

(6) Follow a group of students for more than one year.

(7) Use multi-sensory lessons and visual strategies.

(8) Identify and tend intellectual strengths.

(9) Teach self regulation, advance planning, take-down, clean-up and evaluation.

(10) Communicate with parents.

(11) Teach meta-cognition, thinking strategies and brain research theory to the students.

(12) Learn to recognize signs of depression.

(13) Ask for help.

What Administrators Can Do

(1) Limit class sizes.

(2) Increase planning time for teachers.

(3) Foster an atmosphere where individual differences are valued and celebrated.

(4) Encourage a "revolving door", interest-based gifted program.

(5) Provide adequate time and resources for teacher training.

(6) Support and participate in IEP (Individual Educational Planning), MAPS (Magill Action Planning System) and Circle building for a broader range of students than solely the identified Special-Ed students.

(6) Facilitate access to support personnel.

(7) Welcome parents as part of the educational team.

Conclusion

Ruby Mae Has Something to Say is the title of a delightful picture book by David Small (1992). In this story, a young boy helps his aunt learn to speak without getting all mixed up, as she usually does, with the invention of a bobatron. This appliance, made of kitchen utensils, is worn on the head. It enables Ruby Mae to overcome her language difficulties to deliver a very important message.

Like Ruby Mae, people who struggle with communication difficulties often work to heroic proportions. They create, analyze, synthesize, discover, invent, dissect, study, reflect, and combine. In fact they climb all over Bloom's Taxonomy. They find a way to communicate. The knowledge that one's message has been successfully delivered gives a sense of satisfaction and well-being. Through the process of communicating, self-mastery is discovered, developed, honed, and polished. Overcoming entropy and inertia, they move into +I+M+C grouping.

Most important in developing communication skills is having something to communicate. This creates movement and momentum towards expression. This paper is dedicated to all the Ruby Maes in the world with hopes they will uncover their own personal bobatron, and in doing so, find their voice.

The focus of this paper has been on people who are limited in ease of communication, and rich in creativity. We have an opportunity to create a safe time and place, where talents can be broadened and developed. Here a person's weaknesses are identified and built up. It is where a person with an uneven neurology can be comfortable and feel good about the interesting person he or she is. The classroom could become a space where a person with uneven development can learn better strategies than depression, maladaptive behaviors or violence. A healthy learning community could become a place where differences are not only accepted, but celebrated. If a high quality education were to be delivered, if each student were taught according to his or her need, then the future Einsteins and Piccassos, Lincolns and Mozarts could arise to lead us safely into the future, a future where the experience of the few is as worthy as the experience of the many.

With limited resources and over-crowded classrooms, this utopian vision appears far distant. To even head in that direction, we must upgrade the quality of educational services. Learning how to meet the divergent needs of these three populations simultaneously, would be in and of itself, an improvement of the quality of education available to all.

A proactive, preventive strategy might be used. It is possible that the first and second degree relatives of people with autism are a significant group who could be targeted for evaluation and consultation. They could be monitored and services provided. This might be administered through a private agency like the Autism Society. By infusing those at-risk with watchful support, enrichment, and early intervention, a safety net would be built which would allow more +I-C individuals to thrive and contribute productively.

Autism, itself, would become a genetic marker, signaling where the help is needed. A few dollars spent in prevention would create a savings of lives, talents, wellness, and self esteem, as well as in economic gains. Preventing problems from developing rather than "putting out brush-fires" would have its cost; in the long run, though, it would create a positive return which would feed back into society with compounded interest. In the language of chaos, it could become an *iteration.*

There may, very well, be other genetic markers. Those are for another author.

Bibliography

Allport, G., Pattern and Growth in Personality. (1961). NY: Holt, Reinhart and Winston.

Akshoomoff, N., Courchesne E., A new Role for the Cerebellum in Cognitive Operations. (1992). Behavioral Neuralscience. 106.

Asher, J., Born to be Shy? (1987, April). Psychology Today. NY: Sussex.

Barton, S.,. Chaos, Self-Organization, and Psychology. (1994, January). American Psychologist. Washington D.C.

Baum, S., Gifted But Learning Disabled: A Puzzling Paradox. ERIC Digest #E479, EC-90.

Begley, S., Springen, K., Life in a Parallel World, A Bold New Approach to the Mystery of Autism. (1996, May 13). Newsweek. NY: Newsweek Inc.

Bireley, M., Langus, M., Williamson, T., (1992). Physiological Uniqueness: A New Perspective on the the Learning Disabled/Gifted Child. Roeper Review, *14.*

Caine, G., Making Connections: Teaching and the Human Brain *. (1991). Alexandra, VA: Association for Supervision and Curriculum development.*

Courchesne, E., Saitoh, O., Yeung-Courchesne, R., Press, N., Lincoln, A., Haas, R., Schreibman, L., Abnormality of Cerebellar Vermain Lobules VI and VII in patients with Infantile Autism: Identification of Hypoplastic and Hyperplaastic Subgroups with MR Imaging . (1994, January). AJR*: 162.*

DeArmond, S., Fusco, M., Dewey,M., Structure of the Human Brain, A Photographic Atlas, Third Edition *. (1989) Oxford: Oxford University Press.*

DeLong, G., Dwyer, J., Correlation of Family History with Specific Autistic Subgroups: Asperger's Syndrome and Bipolar Affective Disease . (1988, November 4). Journal of Autism and Developmental Disorders*. 18.*

Demasio, A., Descartes Error, Emotion, Reason, and the Human Brain *. (1994). NY: Putnam and Sons.*

Diagnosing Bill Gates . (1994, January 24). Time Magazine. Time Inc. NY: New York.

Dunn, R., Dunn K., Teaching Elementary Students Through Their Individual Learning Styles: A Practical Approach . (1992). MA: Allyn and Bacon.

Edwards, B., Drawing on the Right Side of the Brain, (1979). CA: J.P. Tarcher.

Ehlers, C., Chaos and Complexity, Can It Help Us Understand Mood and Behavior ? (1995, November). *Archives of General Psychiatry. 52.*

Frith, U., Autism and Asperger Syndrome . (1991). Cambridge: Cambridge University Press.

Folstein, S., Rutter, M., Infantile Autism: A Genetic Study of 21 Twin Pairs. (1977). Journal of Child Psychiatry . Number 19.

Gallagher, J., Gallagher S. Teaching the Gifted Child, Fourth Edition . (1994). MA: Allyn and Bacon.

Gardner, H., Frames of Mind, (1993) NY: Basic Books

Gleick, J., Chaos, Making a New Science . (1987). NY: Penguin Books.

Getner, D., Stevens A., Mental Models . (1983.) NJ: Lawrence Erlbaum Associates.

Glenshaft, J., Birelely, M., Hollinger, C., Serving Gifted and Talented Students, A Resource for School Personel . (1995). Austin, TX: Pro-ed.

Goleman, D., 1,528 Little Geniuses and How They Grew . (1960, February). Psycholog Today . New York: Sussex.

Grandin, T.,. Thinking in Pictures and other Reports from My Life with Autism. (1995). NY: Doubleday.

Hart, C., Beyond Reason, A Family Copes with Two Generations of Autism . (1989). NY: Harper and Row.

House, E., Pansky, B., A Functional Approach to Neuroanatomy. (1960). NY: McGraw-Hill.

Jamison, K., Touched With Fire. (1993). NY: Free Press.

Lane, H., The wild Boy of Aveyron, (1976). Harvard University Press. Cambridge: MA

McDonnell, J., News From the Border, A Mother's Memoir of her Autistic Son. (1993). NY: Ticknor and Fields.

Moss, F., Chaos Under Control. (1994, August). Nature. 370.

Narayan, S., Moyes, B., Wolff, S., Family Characteristics of Autistic Children: A Further Report. (1990). Journal of Autism and Developmental Disorders, 20, 4.

Niesser, U., Cognition and Reality. (1976). San Francisco: W.H. Friedman and Company.

Phillips, J. Jr., Piaget's Theory: A Primer . *(1981). San Francisco: W.H. Freeman and Company.*

Reis, S., Neu, T., McGuire, J. Talents in Two Places: Case Studies of High Ability Students With Learning Disabilities Who Have Achieved . *Executive Summary, National Research Center on the Gifted and Talented. Research Monograph 95113 (1995, Januar). The University of Connecticut, Storrs, Connecticut.*

Rose, S., The Making of Memory, From Molecules to Mind . *(1992). NY: Anchor Books.*

Savage, Woodrum, Children Who are Learning Disabled Gifted: Where Do They Belong ? (1989). ERIC Digest #EC301259

Schumm, J., Vaughn, S., Leavell, A., Planning Pyramid: A Framework for Planning For Diverse Student Needs During Content Area Instruction . (1994, May). The Reading Teacher , *4.*

Small, D., Ruby Mae Has Something To Say. *(1992) Crown Publishers. NT*

Sousa, D., Exploring Brain Research on Learning. (1995). Conference, Midwest Reagonal Teaching and Learning Center, Aquinas College. Grand Rapids: MI.

Patten, B., Visually mediated Thinking: A Report of the Case of Albert Einstein. (1973). Journal of Learning Disabilities, 6, 7.

Revised Administrative Rules for Special Education. (1994, July) Michigan State Board of Education, First Printing.

The Gifted Learning Disabled Student. (1994). City Publications and Resources, The John Hopkins University, ISBN 1-881622-10-x.

Wing, L., Autistic Children. (1985). NY: Brunner - Maze.